Los Alamos scientists recognized with breakthrough prize for neutrinos research

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$3 million award goes to more than 1,300 scientists across five experiments

LOS ALAMOS, N.M., Nov. 12, 2015—More than 1,300 scientists—including 35 from Los Alamos National Laboratory—were awarded the 2016 Breakthrough Prize in Fundamental Physics on November 8 for their work in defining neutrino oscillations across five international experiments that led to the determination that neutrinos have mass. This is the largest group to be awarded the Breakthrough Prize since it was launched three years ago by billionaire venture capitalist Yuri Milner.

“This discovery fundamentally changed our understanding of matter,” said Keith Rielage, a particle astrophysicist at Los Alamos National Laboratory and one of the award recipients. “Knowing that neutrinos have mass allows us to better understand how the universe formed the way it did, leading to galaxies and stars, and even us. Neutrinos are very hard particles to study since they interact so infrequently, so the fact that this research was done and done successfully is a major accomplishment and gives us hope as we look for other particles like dark matter that is even harder to study.”

The $3 million award is the largest cash prize in the field and will be shared among all five experiments ($600,000 each): the Sudbury Neutrino Observatory (SNO), the Super-Kamiokande (Super-K), the KEK-to-Kamioka/Tokai-to-Kamioka (K2K/T2K), the Kamioka Liquid-scintillator Antineutrino Detector (KamLAND), and the Daya Bay Reactor Neutrino Experiment (Daya Bay). Two thirds of those purses will go to the leaders of the experiment and one third to the scientific collaborators.

“It’s a great honor to have so many scientists from Los Alamos recognized as part of this award,” said David Meyerhofer, leader of Los Alamos’ Physics division. “Los Alamos has been involved in neutrino detection since the 1950s when Fred Reines and Clyde Cowan, Jr. led an effort that resulted in the first experimental proof that the elusive particle existed. Since the 1990s, the lab has helped prove that neutrinos oscillate and have mass. We continue to be involved in projects that are trying to uncover the properties of this intriguing particle.”

This award comes on the heels of the Nobel Prize in physics, which was awarded to the Takaaki Kajita of Super-K and Arthur McDonals of SNO. Unlike the Nobel, however, which is awarded only to the experiment leaders, the Breakthrough Prize recognizes all members of the teams that led to the findings.

The Los Alamos connection

Los Alamos National Laboratory was instrumental in the design, assembly and data analysis of the SNO experiment. One of Los Alamos’ major contributions was the development and assembly of the neutral current detector array (NCD) that operated from 2003 to 2006 in SNO. NCD made an independent measurement of the total solar neutrino flux, which, in turn, confirmed its previous result that neutrinos have mass and change type between the sun and earth. Los Alamos also played major roles in delivering low-background photomultiplier tubes for the experiment, in the creation of a number of custom calibration sources that were used to calibrate the detector, and in data acquisition software and data analysis and simulations.

In addition, two current Los Alamos scientists contributed to the Super-K experiment. Christopher Mauger had a significant role in the calibration and simulation of the detector and received his PhD from Stony Brook University on neutrino oscillations. Todd Haines worked on Super-K’s veto system, calibrations and analysis. He started his work at the University of Maryland and continued it while an Oppenheimer Fellow at Los Alamos.

Also recognized were Johnny Goett and Wenqin Xu who had roles on the Daya Bay Reactor Neutrino Experiment sited in China before they came to LANL as postdocs several years ago.

Understanding neutrinos

Neutrinos are one of the most numerous particles in the entire universe, second only to particles of light. There are three types of neutrinos: electron, muon and tau. Most neutrinos that make it to Earth come from the sun, but others come from cosmic rays, exploding stars, the center of the Earth, nuclear power plants and even nuclear processes within our bodies. They are neutral and rarely interact with other matter. In fact, thousands of trillions of neutrinos pass through our bodies each second.

Prior to the work by these five experiments, neutrinos were thought to be massless. In the 1960s, scientists studying neutrinos from the sun were detecting only a third of the number of particles they expected to see. This deficit led to speculation as to the cause of the discrepancy. Some thought it might be the result of faulty theoretical calculations; some wondered if there were problems with the experiment itself; and others thought that the neutrinos might be changing identity as they travelled from the Sun to the Earth. SNO and Super-K proved that the reason for the deficit was that the neutrinos were changing identity: from electron-neutrinos (which is the only type produced by the sun) to muon- or tau-neutrinos as they reached Earth. Why is this so significant? Because to change identity the neutrinos must have mass. Kamland, K2K/T2K, and Daya Bay further measured these oscillations in neutrinos and antineutrinos.

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